What is claimed is:

1. A method of localizing a target comprising:

transmitting a continuous waveform signal;

receiving an echo signal from said target;

demodulating said echo signal to a baseband to obtain a demodulated echo signal;

estimating a rangewise Mach number, M_r, based on combining energy in cells along hypothesized tracks of a frequency-time diagram for said demodulated echo signal; and

determining a first range of said target based on said rangewise Mach number.

2. The method of claim 1, wherein estimating a rangewise Mach number comprises choosing a frequency detection binwidth, δf_{min}, for said cells from a ratio between a minimum bandwidth of said continuous waveform signal, and a number of said cells in a cycle time, T.

3. The method of claim 1, wherein estimating a rangewise Mach number comprises using matched filters having a minimum baseband frequency resolution, δf_{min}, based on a ratio of an initial frequency of said continuous waveform signal, and a number of said cells in a cycle time, T.

4. The method of claim 1, wherein demodulating comprises mixing said echo signal with said continuous waveform signal using at least one of dual extended duration interlaced demodulation signals, and dual frequency band demodulation signals.

5. The method of claim 1, wherein demodulating comprises:

mixing said echo signal with said continuous waveform signal using dual frequency band demodulation reference signals to demodulate said echo signal to a pass band to obtain a demodulated echo signal; and

demodulating said demodulated echo signal to bring said demodulated echo signal down to said baseband.

6. The method of claim 5 further comprising band passing said demodulated echo signal.

7. The method of claim 1, wherein transmitting said continuous waveform signal further comprises:

determining a frequency separation;

transmitting a continuous waveform upsweep signal; and

transmitting a concurrent continuous waveform downsweep signal, said upsweep signal and said downsweep signal having said frequency separation.

8. The method of claim 7, wherein demodulating said echo signal further comprises:

demodulating an upsweep echo signal to baseband to obtain an upsweep baseband frequency for said upsweep echo signal; and

demodulating a downsweep echo signal to baseband to obtain a downsweep baseband frequency for said downsweep echo signal.

9. The method of claim 8, wherein determining a range further comprises combining said upsweep baseband frequency and said downsweep baseband frequency to determine a range rate and a second range of said target.

10. The method of claim 9, wherein combining said upsweep baseband frequency and said downsweep baseband frequency comprises:

determining a sum and a difference of said upsweep baseband frequency and said downsweep baseband frequency to determine said range rate and said second range, respectively, of said target; and

combining said first range and said second range to localize said target.

11. The method of claim 1, wherein determining said first range comprises:

estimating a frequency difference, Δf, between said transmit signal and said echo signal; and

solving for said range using the relationship:

$$r = -\frac{c}{2\dot{f}_o(1-2M_r)}\left[\frac{\Delta f}{(1-M_r)} + 2M_r f_o + 4M_r(1-M_r)\dot{f}_o T_0\right], \text{ where}$$

f_0 is an initial frequency of said continuous waveform signal, and

T_0 is and observation time less than a cycle time T.

12. A method of localizing a target comprising:

determining a frequency separation;

transmitting a continuous waveform upsweep signal, f_u;

transmitting a concurrent continuous waveform downsweep signal, f_d, said upsweep signal and said downsweep signal having said frequency separation;

receiving an upsweep echo signal from said target;

receiving a downsweep echo signal from said target;

demodulating said upsweep echo signal to baseband to obtain an upsweep baseband frequency for said upsweep echo signal;

demodulating said downsweep echo signal to baseband to obtain a downsweep baseband frequency for said downsweep echo signal; and

combining said upsweep baseband frequency and said downsweep baseband frequency to determine a range of said target.

13. The method of claim 12, wherein combining said upsweep baseband frequency and said downsweep baseband frequency comprises determining a sum and a difference of said upsweep baseband frequency and said downsweep baseband frequency to determine a range rate and said range, respectively, of said target.

14. The method of claim 12, wherein said frequency separation is determined based on maintaining said frequency separation at least as large as a potential Doppler shift taken from a relationship $f_1 - f_2 = 4M_{\max} f_0$, wherein said Doppler shift of said continuous waveform upsweep signal and said continuous waveform downsweep signal is expressed as $f_u = f_1 + \dot{f}_0 t$

and $f_d = f_2 + \dot{f}_0 t$, respectively, M_{max} is a maximum rangewise Mach number, and

$f_0 \equiv \left(\frac{f_1 + f_2}{2} \right)$.

15. The method of claim 14, wherein combining said upsweep baseband frequency and said downsweep baseband frequency comprises:

determining a range rate from a sum of said upsweep baseband frequency and said downsweep baseband frequency based on a relationship:

$\Delta f_d(t) + \Delta f_u(t) = -2M_r(f_2 + f_1)$; and

determining said range from a difference of said upsweep baseband frequency and said downsweep baseband frequency based on a relationship:

$\Delta f_d(t) - \Delta f_u(t) = +2\tau_0 \dot{f}_0(1 - 2M_r) + 8M_r(1 - M_r)\dot{f}_0 t - 2M_r(f_2 - f_1)$, where

$\tau_o \equiv \frac{2r}{c}$, r is said range, and c is speed.

16. The method of claim 12, wherein demodulating said upsweep echo signal and said downsweep echo signal comprises:

mixing said upsweep echo signal with said continuous waveform upsweep signal; and

mixing said downsweep echo signal with said continuous waveform downsweep signal, wherein said mixing uses at least one of dual extended duration interlaced demodulation signals, and dual frequency band demodulation signals.

17. A system for localizing a target comprising:

a transmitter to transmit a continuous waveform signal;

a receiver to receive an echo signal from said target; and

a signal processor to demodulate said echo signal to baseband, estimate a rangewise Mach number, M_r, based on combining energy in cells along hypothesized tracks of a frequency-time diagram for said echo signal, and determine a range of said target based on said rangewise Mach number.

18. A system for localizing a target comprising:

means for transmitting a continuous waveform signal;

means for receiving an echo signal from said target;

means for demodulating said echo signal to baseband;

means for estimating a rangewise Mach number, M_r, based on combining energy in cells along hypothesized tracks of a frequency-time diagram for said echo signal;

means for determining a range of said target based on said rangewise Mach number.

19. A system for localizing a target comprising:

means for determining a frequency separation;

means for transmitting a continuous waveform upsweep signal, f_u;

means for transmitting a concurrent continuous waveform downsweep signal, f_d, said upsweep signal and said downsweep signal having said frequency separation;

means for receiving an upsweep echo signal from said target;

means for receiving a downsweep echo signal from said target;

means for demodulating said upsweep echo signal to baseband to obtain an upsweep baseband frequency for said upsweep echo signal;

means for demodulating said downsweep echo signal to baseband to obtain a downsweep baseband frequency for said downsweep echo signal; and

means for combining said upsweep baseband frequency and said downsweep baseband frequency to determine a range of said target.

20. A computer-readable medium containing instructions for controlling a computer system to localize a target by controlling said computer system to:

transmit a continuous waveform signal;

receive an echo signal from said target;

demodulate said echo signal to baseband;

estimate a rangewise Mach number, M_r, based on combining energy in cells along hypothesized tracks of a frequency-time diagram for said echo signal; and

determine a range of said target based on said rangewise Mach number.

21. The computer-readable medium of claim 20, wherein said instructions to estimate a rangewise Mach number comprise instructions to choose a frequency detection binwidth, δf_{min},

for said cells from a ratio of a minimum bandwidth of said continuous waveform signal, and a number of said cells in a cycle time, T.

22. The computer-readable medium of claim 20, wherein said instructions to estimate a rangewise Mach number comprise instructions to use matched filters having a minimum baseband frequency resolution, δf_{min}, based on a ratio of an initial frequency of said continuous waveform signal, and a number of said cells in a cycle time, T.

23. The computer-readable medium of claim 20, wherein said instructions to demodulate comprise instructions to mix said echo signal with said continuous waveform signal using at least one of dual extended duration interlaced demodulation signals, and dual frequency band demodulation signals.

24. The computer-readable medium of claim 20, wherein said instructions to demodulate comprise instructions to:

mix said echo signal with said continuous waveform signal using dual frequency band demodulation reference signals to demodulate said echo signal to a pass band to obtain a demodulated echo signal; and

demodulate said demodulated echo signal to bring said demodulated echo signal down to said baseband.

25. The computer-readable medium of claim 24 further comprising instructions to band pass said demodulated echo signal.

26. The computer-readable medium of claim 20, wherein said instructions to transmit said continuous waveform signal further comprise instructions to:

determine a frequency separation;

transmit a continuous waveform upsweep signal; and

transmit a concurrent continuous waveform downsweep signal, said upsweep signal and said downsweep signal having said frequency separation.

27. The computer-readable medium of claim 26, wherein said instructions to demodulate said echo signal further comprise instructions to:

demodulate an upsweep echo signal to baseband to obtain an upsweep baseband frequency for said upsweep echo signal; and

demodulate a downsweep echo signal to baseband to obtain a downsweep baseband frequency for said downsweep echo signal.

28. The computer-readable medium of claim 27, wherein said instructions to determine a range further comprise instructions to combine said upsweep baseband frequency and said downsweep baseband frequency to determine a range rate and a second range of said target.

29. The computer-readable medium of claim 28, wherein said instructions to combine said upsweep baseband frequency and said downsweep baseband frequency comprise instructions to:

determine a sum and a difference of said upsweep baseband frequency and said downsweep baseband frequency to determine said range rate and said second range, respectively, of said target; and

combine said first range and said second range to localize said target.

30. The computer-readable medium of claim 20, wherein said instructions to determine said first range comprise instructions to:

estimate a frequency difference, Δf, between said transmit signal and said echo signal; and

solve for said range using the relationship:

$$r = -\frac{c}{2\dot{f}_o(1-2M_r)}\left[\frac{\Delta f}{(1-M_r)} + 2M_r f_o + 4M_r(1-M_r)\dot{f}_o T_0\right], \text{ where}$$

f_0 is an initial frequency of said continuous waveform signal, and

T_0 is and observation time less than a cycle time T.

31. A computer-readable medium containing instructions for controlling a computer system to localize a target by controlling said computer system to:

determine a frequency separation;

transmit a continuous waveform upsweep signal, f_u;

transmit a concurrent continuous waveform downsweep signal, f_d, said upsweep signal and said downsweep signal having said frequency separation;

receive an upsweep echo signal from said target;

receive a downsweep echo signal from said target;

demodulate said upsweep echo signal to baseband to obtain an upsweep baseband frequency for said upsweep echo signal;

demodulate said downsweep echo signal to baseband to obtain a downsweep baseband frequency for said downsweep echo signal; and

combine said upsweep baseband frequency and said downsweep baseband frequency to determine a range of said target.

32. The computer-readable medium of claim 31, wherein said instructions to combine said upsweep baseband frequency and said downsweep baseband frequency comprise instructions to determine a sum and a difference of said upsweep baseband frequency and said downsweep baseband frequency to determine a range rate and said range, respectively, of said target.

33. The computer-readable medium of claim 31, wherein said instructions to determine a frequency separation comprise instructions to maintain said frequency separation at least as large as a potential Doppler shift taken from a relationship $f_1 - f_2 = 4M_{\max} f_0$, wherein said Doppler shift of said continuous waveform upsweep signal and said continuous waveform downsweep signal is expressed as $f_u = f_1 + \dot{f}_0 t$ and $f_d = f_2 + \dot{f}_0 t$, respectively, M_{max} is a maximum rangewise Mach number, and $f_0 \equiv \left(\frac{f_1 + f_2}{2} \right)$.

34. The computer-readable medium of claim 33, wherein said instructions to combine said upsweep baseband frequency and said downsweep baseband frequency comprise instructions to:

determine a range rate from a sum of said upsweep baseband frequency and said downsweep baseband frequency based on a relationship:

$\Delta f_d(t) + \Delta f_u(t) = -2M_r(f_2 + f_1)$; and

determine said range from a difference of said upsweep baseband frequency and said downsweep baseband frequency based on a relationship:

$\Delta f_d(t) - \Delta f_u(t) = +2\tau_0 \dot{f}_0(1-2M_r) + 8M_r(1-M_r)\dot{f}_0 t - 2M_r(f_2 - f_1)$, where

$\tau_o \equiv \frac{2r}{c}$, r is said range, and c is speed.

35. The computer-readable medium of claim 31, wherein said instructions to demodulate said upsweep echo signal and said downsweep echo signal comprise instructions to:

mix said upsweep echo signal with said continuous waveform upsweep signal; and

mix said downsweep echo signal with said continuous waveform downsweep signal, wherein said mixing uses at least one of dual extended duration interlaced demodulation signals, and dual frequency band demodulation signals.